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CLAIMS

1. A reciprocating gas compressor operating according to an extended cycle of 4, 6 or more strokes, wherein the first two strokes are sequential induction and compression strokes using a low pressure gas as working fluid and compressing it to a high pressure gas, and the remaining strokes are pairs of sequential filling and emptying strokes using more of the low pressure gas as heat transfer fluid for transferring heat from inside the gas compressor to outside the gas compressor.

2. A reciprocating gas expander operating according to an extended cycle of 4, 6 or more strokes, wherein the first two strokes are sequential expansion and exhaust strokes using a high pressure gas as working fluid to produce power by expansion, and the remaining strokes are pairs of sequential filling and emptying strokes using warm air or warmed exhaust gas as heat transfer fluid for transferring heat from outside the expander to inside the gas expander.

3. A reciprocating gas compressor as claimed in claim 1, operating as a single stage or multi-stage gas compressor, each stage comprising at least one cylinder 100 having a variable volume defined by a reciprocating piston 120 which draws gas (working fluid) from the an upstream gas supply into the cylinder during the induction stroke and compresses the gas to a high pressure before the gas is released to a downstream high pressure gas reservoir 320 during the compression stroke, characterised in that an open matrix heat regenerator 140 of high heat capacity is provided occupying the clearance space in the cylinder, and the reciprocating gas compressor is operated according to an extended cycle comprising after the said induction and compression strokes, at least one pair of extra strokes each pair consisting of a filling stroke in which more gas (heat

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transfer fluid) from the upstream gas supply is drawn by the piston 120 into the cylinder 100 to fill the cylinder followed immediately by an emptying stroke in which the filled gas is expelled by the piston 120 out of the cylinder 100 back to the upstream gas supply, such that the filled heat transfer gas cools the heat regenerator 140 inside the cylinder 100 and lowers the heat regenerator temperature close to the temperature of the filled gas during the extra strokes, before the extended cycle is repeated with the working fluid of fresh gas from the upstream gas supply inducted into the cylinder and compressed while being cooled by the heat regenerator 140 during the next compression stroke.

4. A reciprocating gas expander as claimed in claim 2, operating as a single stage or multi-stage gas expander, each stage comprising at least one cylinder 10 having a variable volume defined by a reciprocating piston 12 which produces work when a predetermined quantity of high pressure gas serving as working fluid is admitted into the cylinder and allowed to expand against the piston to produce power during the expansion stroke, and the expanded gas is subsequently expelled from the cylinder displaced by the piston during the exhaust stroke, characterised in that an open matrix heat regenerator 14 of high heat capacity is provided occupying the clearance space in the cylinder 10, and the reciprocating gas expander is operated according to an extended cycle comprising after the said expansion and exhaust strokes, at least one pair of extra strokes each pair consisting of a filling stroke in which warm air or warmed expelled gas serving as heat transfer fluid is drawn by the piston 12 into the cylinder 10 to fill the cylinder followed immediately by an emptying stroke in which the filled gas is expelled by the piston out of the cylinder, such that the filled gas warms the heat regenerator 14 inside the cylinder 10 and raises the heat regenerator temperature close to the temperature of the filled gas

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during the extra strokes, before the extended cycle is repeated with the working fluid of fresh high pressure gas admitted into the cylinder, warmed by the heat regenerator 14 while expanding to produce power during the next expansion stroke.

5. A modified Ericsson cycle engine including one or both of an extended cycle reciprocating gas compressor as claimed in claim 3 and an extended cycle reciprocating gas expander as claimed in claim 4.

6. A modified Ericsson cycle engine as claimed in claim 5, wherein more gas is used as heat transfer fluid in both said gas compressor and gas expander during the extra strokes of the respective extended cycles of the compressor and expander, and wherein during engine operation, heat addition to the engine is achieved by heating the heat transfer fluid entering the gas expander, and the heat transfer fluid transferring heat to the heat regenerator 14 in the gas expander for heating the compressed gas working fluid in the gas expander.

7. A modified Stirling cycle engine including one or both of an extended cycle reciprocating gas compressor as claimed in claim 3 and an extended cycle reciprocating gas expander as claimed in claim 4.

8. A modified Stirling cycle engine as claimed in claim 7, wherein a separate return connection 72, 70 containing a recuperative heat regenerator 78 is provided for the expanded gas working fluid from the gas expander to be returned along the said connection to the gas compressor, and for more gas used as heat transfer fluid to be exchanged also along the said connection between the said compressor and said expander during the extra strokes of the respective extended cycles of the compressor and expander, such that the recuperative heat regenerator 78 in the said separate

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return connection 72, 70 absorbs heat from the working fluid and heat transfer fluid when the fluids flow through it in the direction from the gas expander to the gas compressor and releases heat to the heat transfer fluid when the fluid
5 flows through it in the direction from the gas compressor to the gas expander.

9. A modified Stirling cycle refrigerator driven by a motor or an engine, the refrigerator including one or both
10 of an extended cycle reciprocating gas compressor as claimed in claim 3 and an extended cycle reciprocating gas expander as claimed in claim 4.

10. A modified Stirling cycle refrigerator as claimed
15 in claim 9, wherein a separate return connection 72, 70 containing a recuperative heat regenerator 78 is provided for the expanded gas working fluid from the gas expander to be returned along the said connection to the gas compressor, and for more gas used as heat transfer fluid to be exchanged
20 also along the said connection between the said compressor and said expander during the extra strokes of the respective extended cycles of the compressor and expander, such that the recuperative heat regenerator 78 in the said separate return connection 72, 20 releases heat to the working fluid
25 and heat transfer fluid when the fluids flow through it in the direction from the gas expander to the gas compressor and absorbs heat from the heat transfer fluid when the fluid flows through it in the direction from the gas compressor to the gas expander.

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